FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: **216636US3PCT**

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR): **09/926676**

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP00/03597	**2 June 2000**	**2 June 1999**

TITLE OF INVENTION
VACUUM PROCESSING APPARATUS

APPLICANT(S) FOR DO/EO/US
Jun HIROSE, et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☒ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

Amended Sheets (Pages 21, 21/1, 22, 22/1, 23, 24, and 24/1) Filed April, 4, 2001 **Form PTO 1449**
Amended Sheets (Pages 22/1 23, 24/2 and 24/3) Filed June 21, 2001
Notice of Priority
Drawings (5 Sheets)

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
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24. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**	
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**	
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**	
☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**	
☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
	ENTER APPROPRIATE BASIC FEE AMOUNT =	**$890.00**
	Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	15 - 20 =	0	x $18.00	**$0.00**
Independent claims	3 - 3 =	0	x $84.00	**$0.00**
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**
	TOTAL OF ABOVE CALCULATIONS =			**$890.00**
☐	Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.			**$0.00**
	SUBTOTAL =			**$890.00**
	Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +			**$0.00**
	TOTAL NATIONAL FEE =			**$890.00**
☒	Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			**$40.00**
	TOTAL FEES ENCLOSED =			**$930.00**
				Amount to be: refunded $
				charged $

a. ☒ A check in the amount of **$930.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **15-0030** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Nov. 30 2001
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5/p.1b

DESCRIPTION

VACUUM PROCESSING APPARATUS

Technical Field

The present invention relates to a vacuum processing apparatus for forming a film or etching for a substrate to be processed by a semiconductor manufacturing technique using plasma.

Background Art

There is normally known a plasma processing apparatus forming a thin film, such as a CVD (chemical vapor deposition) system, or for selective etching, such as an RIE (reactive ion etching) system, using plasma with respect to the surface of a substrate to be processed while disposing the substrate, e.g., a liquid crystal glass substrate or a semiconductor wafer, in a processing chamber which is exhausted by an exhausting system to form a vacuum.

FIG. 10 is a schematic block diagram of a conventional plasma processing apparatus.

This plasma processing apparatus 1 has a cylindrical processing chamber 2 exhausted by an exhausting system, which is not shown, and a stage 4 supported by a driving shaft 3 such as a ball screw and provided in the chamber 2. The stage 4 is made flat so that a substrate to be processed (e.g., a liquid

crystal glass substrate or a semiconductor wafer) 5 can be mounted on the stage 4. In addition, a bellows 6 is provided between the lower portion of the stage 4 and the bottom of the vacuum processing chamber 2 to airtightly surround the driving shaft 3. The interior of this bellows 6 communicates with an exterior and has atmospheric pressure.

Further, a carrier port 7 freely opened and closed by a gate valve, which is not shown, is provided almost at the center of the inner peripheral wall of the processing chamber 2. The substrate held by a carrier arm, which is not shown, is carried into the processing chamber 2 through the port 7 from the outside and mounted on the stage 4 or the substrate which has been treated is carried out of the processing chamber 2 through the port 7.

Accordingly, the portion of the carrier port 7 appears concave if seen from the inner peripheral wall surface of the processing chamber 2. In this state, if plasma is generated, the uniformity of plasma density is disordered. If this processing chamber 2 is applied to, for example, a CVD apparatus, problems occur. One of these problems is that the distribution of the thickness of a film deposited on the substrate becomes uneven.

Considering the problems, the vertically movable stage 4 as stated above is provided. When the

substrate is carried into and out of the processing chamber 2, the stage 4 is moved slightly downward of the carrier port 7 as indicated by a two-dot chain line in FIG. 10, and the substrate 5 is handled by the transport arm. After the substrate 5 is mounted on the stage 4, the stage 4 is raised so as to prevent the concave portion of the carrier port 7 from being applied with generated plasma.

The plasma processing apparatus having the vertically movable stage 4 stated above requires a space to vertically move the stage in the processing chamber. To do so, it is necessary to make the height dimension of the processing chamber 2 large. This disadvantageously makes the overall processing apparatus large in size.

Furthermore, clearances 8 serving as movement margins are provided between the stage 4 and the inner peripheral walls of the processing chamber 2, respectively so as to vertically move the stage 4. Due to this, if plasma is generated, plasma spreads toward the lower side of the stage 4 through these clearances 8, disadvantageously making plasma density into disorder.

To solve these problems, according to a plasma processing apparatus disclosed by, for example, Jpn. Pat. Appln. KOKAI Publication No. 63-275117, a plurality of magnetic members are disposed to surround

a space ranging from a plasma withdrawal port to a substrate to be processed in a chamber and these magnetic members form magnetic lines of force in a direction perpendicular to a plasma flow to thereby control the diameter of the plasma flow.

By doing so, plasma diffusion is suppressed, plasma density is made uniform and a uniform plasma processing conducted even to a substrate to be processing having a large diameter is realized. With this technique, however, it is necessary to provide motors and driving units independently of one another for the plural magnetic members so that the magnetic members generate magnetic fields in the direction perpendicular to the plasma flow, which disadvantageously complicates the structure of the apparatus.

Disclosure of Invention

It is an object of the present invention to provide a vacuum processing apparatus which can prevent plasma from spreading into a carrier port for carrying a substrate to be processed into and out of a chamber when plasma is generated, which can eliminate the disorder of plasma to ensure a uniform plasma processing, which is simple in structure and which can be made small in size.

To obtain the above object, the present invention provides a vacuum processing apparatus comprising: a

vacuum processing chamber having a stage mounting a substrate to be processed thereon; and a carrier port provided on a peripheral wall of the vacuum processing chamber, and carrying the substrate onto and off the stage, for generating plasma in the vacuum processing chamber and for subjecting the substrate on the stage to a plasma processing, wherein a shutter closes the carrier port when the plasma is generated in the vacuum processing chamber to thereby prevent the plasma from being disordered.

In addition, the shutter is a cylindrical member along an inner peripheral wall of the vacuum processing chamber, and is raised by a shutter driving mechanism to close the carrier port when the plasma is generated in the vacuum processing chamber. The shutter is a plate member along an inner peripheral wall of the vacuum processing chamber, and is raised by a shutter driving mechanism to close the carrier port when the plasma is generated in the vacuum processing chamber.

Further, the shutter driving mechanism is constituted out of an air cylinder disposed on an atmospheric side, and a driving shaft elevated by the air cylinder to elevate the shutter.

The vacuum processing apparatus constituted as stated above allows the shutter to be raised by an air cylinder and the carrier port for carrying the substrate into and out of the vacuum processing chamber

to be closed by the shutter to eliminate uneven portions on the inner peripheral wall of the vacuum processing chamber when the plasma is generated, thereby making it possible to eliminate the disorder of the plasma and to ensure a uniform plasma processing.

Brief Description of Drawings

FIG. 1 is a view showing the longitudinal sectional structure of a vacuum processing apparatus in a first embodiment for carrying out the present invention.

FIG. 2 is a front view of a shutter drive unit in the first embodiment for carrying out the present invention.

FIG. 3 is a perspective view of a shutter in the first embodiment for carrying out the present invention.

FIG. 4 is a view showing the cross-sectional structure of a processing chamber showing a second embodiment for carrying out the invention.

FIG. 5 is a perspective view of a shutter drive unit in the second embodiment for carrying out the invention.

FIG. 6 is a view showing the longitudinal sectional structure of a vacuum processing apparatus in a third embodiment for carrying out the invention.

FIG. 7 is a perspective view of a shutter drive unit in the third embodiment for carrying out the

invention.

FIGS. 8A and 8B are views showing the cross-sectional structure of the shutter drive unit in the third embodiment for carrying out the invention.

FIG. 9 is a view showing the cross-sectional structure of a shutter drive unit in a modified example of the third embodiment for carrying out the invention.

FIG. 10 is a view showing the longitudinal sectional structure of a conventional vacuum processing apparatus.

Best Mode for Carrying Out of the Invention

Embodiments for carrying out the present invention will be described hereinafter in detail.

FIGS. 1 through 3 show a first embodiment for carrying out the invention. FIG. 1 is a longitudinal front view of a vacuum processing apparatus, FIG. 2 is a front view of a shutter drive unit and FIG. 3 is a perspective view of a shutter.

As shown in FIG. 1, a processing chamber 11 constituting the main body of a vacuum processing apparatus is formed out of a conductive material such as, for example, aluminum. The interior of the processing chamber 11 is vertically partitioned by a ring-shaped partition wall 13 into an upper portion used as a vacuum processing area 14 and a lower portion used as an atmospheric area 15.

A stage 16 is provided at the center of this

partition wall 13. An insulating member made of quartz or the like is arranged on the upper surface of this stage 16 to provide a mounting surface 16a on which a substrate to be processed 17, such as a liquid crystal glass substrate or a semiconductor wafer, is mounted.

The surface of the stage 16 is made of aluminum or the like and subjected to, for example, an alumite treatment (anode oxide coating). A heating region such as a ceramic heater, a temperature control mechanism such as a coolant channel and a temperature sensor (these elements are not shown) are provided inside the stage 16.

A carrier port 18 for carrying the substrate 17 onto and out of the mounting surface 16a by a carrier arm (not shown) is provided on a part of the peripheral wall of the processing chamber 11 constituting a vacuum processing area 14. This carrier port 18 has a flat rectangular shape along the peripheral direction of the processing chamber 11 and has a protrusion port 19 formed integrally with the carrier port 18 and protruding from the opening edge to the outside.

Further, a shutter 20 is provided along the inner peripheral wall of the processing chamber 11 to be freely elevated. As shown in FIGS. 2 and 3, this shutter 20 is made of the same conductive material as that of the processing chamber 11 such as aluminum and is a cylindrical body having an opening at both ends.

The shutter 20 is formed such that the height of the peripheral wall is large enough to close the carrier port 18. The shutter 20 is vertically moved by a shutter drive mechanism 21 to be described later.

Further, an electric heater 20a is built in the shutter 20. The heater 20a has functions of preventing heat loss, improving processing efficiency, suppressing the adhesion of a reactive product and lengthening a maintenance cycle. The potential of the shutter 20 is grounded.

Next, the shutter driving mechanism 21 will be described.

An air cylinder 22 is attached to the atmospheric area 15 on the lower portion of the processing chamber 11 by an attachment tool 23 in a vertical direction. A ring-shaped elevation plate 25 is horizontally fixed to the elevation rod 24 of the air cylinder 22.

A plurality of driving shafts 26 are provided on the elevation plate 25 in the vertical direction of the plate 25. The shutter 20 is fixed to the upper ends of these driving shafts 26 by screws. The driving shafts 26 are axially, slidably provided in guide holes 27 penetrating the partition wall 13, and a seal member 28 and a slide bearing 29 are provided in each guide hole 27.

By elevating the elevation rod 24 by the air cylinder 22, the shutter 20 is elevated through the

elevation plate 25 and the driving shafts 26. The carrier port 18 is opened by the shutter 20 at a shutter descending position and closed by the shutter 20 at a shutter rising position, and an even, flat surface is formed on the peripheral wall of the vacuum processing area 14. The shutter 20 also functions as a deposit shield.

Next, the function of the first embodiment for carrying out the invention will be described.

First, the elevation rod 24 is descended by the air cylinder 22, and the shutter 20 is descended and retreated through the elevation plate 25 and the driving shafts 26. Then, the carrier port 18 is opened. In this state, the substrate to be processed 17 held by the carrier arm is carried through the carrier port 18 into the vacuum processing area 14 and mounted on the mounting surface 16a of the stage 16.

Next, the carrier port 18 is closed by a gate valve (not shown) and the vacuum processing area 14 is exhausted to form a vacuum. It is noted that the vacuum processing area 14 may be evacuated in advance. After the vacuum processing area 14 has a predetermined degree of vacuum, process gas is introduced into the vacuum processing area 14. At the same time, the air cylinder 22 is driven to raise the elevation rode 24. Then, the shutter 20 is raised through the elevation plate 25 and the driving shafts 26 to close the carrier

port 18. As a result, an even, flat surface is formed on the peripheral wall of the vacuum processing area 14.

Next, plasma is generated in the vacuum processing area 14 to subject the substrate 17 to a plasma processing. At this moment, the shutter 20 cylindrically surrounds a plasma generation region. Since this shutter 20 has no uneven portions, a plasma flow has no deviation and the uniformity of the plasma processing is ensured even for the substrate 17 having a large diameter. For example, if a film is formed on the substrate 17 by plasma CVD, a uniform film thickness can be obtained.

Furthermore, it is not necessary to elevate the stage 16 but it suffices to elevate only the shutter 20 in the vacuum processing area 14. This makes it possible to decrease the height dimension of the vacuum processing area 14, to make the apparatus small in size, to save energy and to reduce cost.

Next, a vacuum processing apparatus according to the second embodiment for carrying out the present invention will be described.

FIG. 4 is a cross-sectional plan view of a processing chamber 11 constituting a vacuum processing area 14 and FIG. 5 is a perspective view of a shutter drive unit. In this embodiment for carrying out the invention, the same constituent elements as those in

the first embodiment for carrying out the invention described above are denoted by the same reference symbols and no detailed description will be given thereto.

A carrier port 30 is provided on a part of the peripheral wall of the processing chamber 11 of this vacuum processing apparatus and opened to have a flat rectangular shape along the peripheral direction of the processing chamber 11. The carrier port 30 has also an opening portion 30a on a lower end thereof.

Further, a gate 31 airtight opening and closing the carrier port 30 is provided in the vacuum processing area 14 to be freely elevated. This gate 31 is made of the same conductive material, such as aluminum, as that of the processing chamber 11, formed into a rectangular plate shape having such a dimension as to close the opening portion of the carrier port 30, and curved to have the same curvature as that of the peripheral wall of the processing chamber 11.

This gate 31 is coupled to the elevation rod 24 of an air cylinder 22 provided on an atmospheric area 15 side on the lower portion of the processing chamber 11 so as to be elevated. At the descending position of the elevation rode 24, the gate 31 is descended to open the carrier port 30. At the rising position thereof, the gate 31 airtight closes the carrier port 30. As a result, no uneven portions appear on the peripheral

wall of the vacuum processing area 14.

According to this embodiment for carrying out the present invention, it suffices that only the gate 31 opening and closing the carrier port 30 is driven to be elevated. As in the case of the above-stated shutter, it is possible to eliminate uneven portions on the peripheral surface of the vacuum processing area 14, to form the gate 31 to be small in size and light in weight, and to make the air cylinder 22 small in size.

Next, a vacuum processing apparatus in a third embodiment for carrying out the present invention will be described.

FIG. 6 is a longitudinal sectional front view of a vacuum processing apparatus in this embodiment for carrying out the present invention.

A processing chamber 41 constituting the main body of this vacuum processing apparatus is formed out of a conductive material such as aluminum. The interior of the processing chamber 41 is vertically partitioned by a ring-shaped partition wall 42 into an upper portion used as a vacuum processing area 43 and a lower portion used as an atmospheric area 44.

A stage 45 is provided at the center of this partition wall 42. An insulating member made of quartz or the like is arranged on the upper surface of this stage 45 to provide a mounting surface 45a on which a substrate to be processed 46, such as a liquid crystal

glass substrate or a semiconductor substrate, is mounted. Also, a disk-shaped evacuation plate 56 is provided around the stage 45. The surface of the stage 45 is made of aluminum or the like subjected to, for example, an alumite treatment (anode oxide coating). A heating region 47 such as a ceramic heater, a temperature control mechanism such as a coolant channel and a temperature sensor (not shown) are provided inside the stage 45.

A carrier port 47 for carrying the substance 46 onto and out of the mounting surface 45a by a carrier arm (not shown) is provided on a part of the inner peripheral wall of the vacuum processing area 43. A gate valve 48 opening and closing the carrier port 47 is provided on the atmospheric side of the carrier port 47. This gate valve 48 is driven by an air cylinder or the like, which is not shown. If the gate valve 48 is closed, the interior of the vacuum processing area 43 is maintained airtight.

In addition, an upper electrode 55 including a gas introduction system is provided in the ceiling plate 54 of the processing chamber 41. Further, a freely elevated shutter 49 and a fixed deposit shield 50 are provided in the vacuum processing area 43 as shown in FIG. 7.

This deposit shield 50 is made of a conductive material such as aluminum, formed into a cylindrical

shape having both ends opened and, as shown in FIG. 6, fixed through a spacer 53 in the vacuum processing area 43. The deposit shield 50 is grounded to have a GND potential equal to the potential of the processing chamber. The deposit shield 50 also has a partial notch portion into which portion the raised shutter 49 is fitted.

Further, an electric heater (not shown) is built in each of the shutter 49 and the deposit shield 50 to so as to function to prevent heat loss in the vacuum processing area 43, to improve treatment efficiency, to suppress the adhesion of a reactive product and to lengthen a maintenance cycle.

This shutter 49 is coupled to one end of a driving shaft 51 airtightly introduced from the atmospheric area 44 on the lower portion of the processing chamber 41 using a magnetic fluid seal or the like. The other end of this driving shaft 51 is coupled to an air cylinder 52. The air cylinder 52 drives the shutter 49 to be vertically elevated. Namely, if the substrate is carried into and out of the processing chamber through the carrier port 47, the shutter 49 is descended to be retreated. When plasma is generated, the shutter 49 is raised to be fitted into the notch portion of the deposit shield 50 to thereby form an even curve.

In a second embodiment for carrying out the invention stated above, to eliminate the height

difference between the raised shutter 31 and the peripheral wall of the processing chamber 11 and to form the same peripheral surface, the shutter 31 is preferably made close to the processing chamber 11 as much as possible. However, if the shutter 31 is raised and abutted on the processing chamber 11, the abutted portions are worn and particles may possibly be generated. If clearances are formed to prevent the abutted portions from being worn, however, the shutter is electrically disconnected from the processing chamber 11. Then, the shutter is exposed to plasma in the processing apparatus using plasma and, therefore, the shutter has sometimes a different potential from that of the processing chamber 11.

To prevent this, as shown in FIG. 8A which is a cross-sectional view taken along A-A of FIG. 7, a spiral seal 61 made of metal such as stainless is used to electrically connect the deposit shield 50 to the shutter 49. That is, a groove containing the spiral seal 61 so that a part of the seal 61 is protruded from the groove is formed on the end face of the shutter 49 and a groove containing an O ring is also formed in parallel to the former groove. At this moment, the spiral seal groove is formed on the processing chamber 41 side whereas the O ring groove is formed on the vacuum area side. In addition, alumite 65 on the inner surface 64 of the spiral seal groove and the contact

surface 63 of the deposit shield 50, on which the spiral seal 61 is abutted, is removed to allow electrical connection.

As shown in FIG. 8B, if the shutter 49 raised by the driving shaft 51 is abutted on the deposit shield 50 and the spiral seal 61 contacts with the contact surface 63 of the deposit shield 50, metallic powder, i.e., particles may possibly be generated. Even so, the O ring 62 can prevent the particles from entering the vacuum processing area 43 side. The O ring also functions to absorb an impact generated when the shutter 49 is abutted on the deposit shield 50.

Alternatively, a spiral seal 66 may be provided so that the shutter 49 can be contacted with and electrically connected to the evacuation plate 56 when the shutter 49 is raised in the same manner.

Next, a modified example of the third embodiment for carrying out the present invention will be described with reference to FIG. 9.

In this modified example, the end faces of the shutter 49 and the deposit shield 50 abutted on each other have different shapes from those in the third embodiment and the abutment of the shutter on the deposit shield is realized without using an O ring.

As shown in FIG. 9, the end faces of the shutter and the deposit shield are L-shaped to engage them with each other. At this moment, the processing chamber 41

side is made higher than the vacuum processing area 43 side, i.e., the outer peripheral side is made convex.

In this modified example as in the case of the third embodiment, the same spiral seal groove as that described above is formed on the convex end face of the shutter 49 and a spiral seal 72 is fitted into the groove, If the shutter 71 is raised, the shutter 71 is abutted on the deposit shield 70 to establish electrical connection therebetween. In this case, because of the L-shaped abutted portions, even if particles are generated at the time of the contact of the spiral seal 72 with the deposit shield 70, the particles are shielded by the L-shaped portions to thereby prevent the particles from reaching the substrate 46. As a result, an even, flat surface is formed on the peripheral wall of the vacuum processing area side. While the O ring is used in the third embodiment for carrying out the invention, a groove can be formed into such a shape, e.g., U-shape, as to generate an elastic force using Teflon or the like.

As stated so far, according to the present invention, the carrier port for carrying the substrate into and out of the vacuum processing chamber is closed by the shutter to thereby eliminate uneven portions on the inner peripheral wall of the vacuum processing area side. By doing so, when plasma is generated, plasma disturbance can be eliminated to advantageously ensure

a uniform plasma processing. Furthermore, since it is not necessary to elevate the mounting base on which the substrate is mounted, it is possible to advantageously simplify the structure of the apparatus and to advantageously make the apparatus small in size.

Moreover, since the deposit shield, the shutter and the evacuation plate have an equal electrical potential (e.g., ground potential), it is possible to eliminate the electrical plasma disturbance and to further ensure a uniform plasma processing.

Industrial Applicability

The present invention is intended to provide a vacuum processing apparatus capable of eliminating plasma disturbance and conducting a uniform plasma processing when the plasma is generated by removing uneven portions from the inner peripheral wall of the vacuum processing area side of the present invention.

The vacuum processing apparatus of the present invention is provided with a vacuum processing chamber in which a predetermined processing is conducted to a substrate to be processed mounted on a stage using plasma, and a shutter covering the inner peripheral wall of the vacuum processing area and vertically moved. This shutter is entirely retreated when the substrate is carried onto and out of the stage through a carrier port, and disposed to surround a plasma generation region when a plasma processing is

conducted, so that the shutter eliminates uneven portions in the vacuum processing area and functions as a deposit shield. Also, a deposit shield is fixed to cover the inner peripheral wall of the vacuum processing area on the outer periphery of the stage, a notch portion to cover the carrier port is provided, and a freely elevated shutter fitted into this notch portion is provided. The shutter is descended to be retreated when the substrate is carried into and out of the processing chamber through the carrier port, and raised to be fitted into the notch portion when a plasma processing is conducted, thereby forming a curve without uneven portions, having an equal potential, eliminating plasma disturbance and ensuring a uniform plasma processing.

C L A I M S

1. (Amended) A vacuum processing apparatus comprising:

a vacuum processing chamber having a stage mounting a substrate to be processed; and

a carrier port provided on a peripheral wall of the vacuum processing chamber, and carrying the substrate onto and off the stage, for generating plasma in the vacuum processing chamber and for subjecting the substrate on the stage to a plasma processing, characterized by comprising:

a shutter having a heating mechanism, retreated when the substrate is delivered onto and off the stage, and disposed to cover a surrounding of the stage and to surround a plasma generation region while closing the carrier port when the plasma is generated in the vacuum processing chamber, to thereby prevent the plasma from being disordered.

2. (Amended) A vacuum processing apparatus according to claim 1, characterized in that

the shutter is a cylindrical member along an inner peripheral wall of the vacuum processing chamber, the shutter raised by a shutter driving mechanism to close the carrier port when the plasma is generated in the vacuum processing chamber.

3. (Amended) A vacuum processing apparatus according to claim 2, characterized in that

the shutter driving mechanism is constituted of an air cylinder disposed on an atmospheric area side, and a driving shaft elevated by the air cylinder to elevate the shutter.

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4. (Amended) A vacuum processing apparatus according to claim 1, characterized in that

the shutter is a plate member along an inner peripheral wall of the vacuum processing chamber, the shutter raised by a shutter driving mechanism to close the carrier port when the plasma is generated in the vacuum processing chamber.

5. (Amended) A vacuum processing apparatus according to claim 3, characterized in that

the shutter driving mechanism is constituted of the air cylinder disposed on the atmospheric area side, and the driving shaft elevated by the air cylinder and elevating the shutter.

6. (Amended) A vacuum processing apparatus according to claim 1, characterized in that

a potential of the shutter is grounded.

7. (Amended) A vacuum processing apparatus, comprising; a vacuum processing chamber having a stage mounting a substrate to be processed; and a carrier port provided on a peripheral wall of the vacuum processing chamber, and carrying the substrate onto and off the stage, for generating plasma in the vacuum processing chamber and for subjecting the substrate on the stage to a plasma processing, characterized by comprising:

a deposit shield disposed along an inner peripheral wall of the vacuum processing chamber; and

a shutter disposed to be able to be elevated along the inner peripheral wall of the vacuum processing chamber, and characterized in that

each of the deposit shield and the shutter has a grounded potential, the shutter is retreated when the substrate is delivered into and outside through the carrier port and displaced to be abutted on the deposit shield when the plasma processing is conducted, and a plasma generation region is surrounded by an even curve, thereby generating uniform plasma.

8. (Amended) A vacuum processing apparatus according to claim 7, characterized in that

the shutter is a cylindrical member along the inner peripheral wall of the vacuum processing chamber, the shutter raised by a shutter driving mechanism to close the carrier port when the plasma is generated in the vacuum processing chamber.

9. (Amended) A vacuum processing apparatus according to claim 7, characterized in that

the shutter is a plate member along the inner peripheral wall of the vacuum processing chamber, and the deposit shield is a cylindrical member having a notch portion facing the carrier port; and

when the plasma is generated in the vacuum processing chamber, the shutter is fitted into the notch portion by a shutter driving mechanism to close the carrier port.

10. (Amended) A vacuum processing apparatus according to claim 7, characterized in that

on an end face of the shutter on the deposit shield side,

the end face is formed to have a flat surface, a groove for fitting an O ring thereinto is formed on the stage side, and a groove for fitting a spiral seal made of metal thereinto is formed on an outer periphery on the groove; and

when the processing is conducted, the deposit shield and the shutter are electrically connected to each other through the spiral seal.

11. (Amended) A vacuum processing apparatus according to claim 7, characterized in that

on an end face of the shutter on the deposit shield side, the end face is formed to have an L-shape to be engaged with an end face of the notch portion so as to have a convex outer periphery on the end face of the shutter; and

a groove for fitting a spiral seal made of metal thereinto is formed on the end face of the convex portion of the shutter is formed, and when the processing is conducted, a concave portion of the deposit shield and the convex portion of the shutter are electrically connected to each other through the spiral seal.

12. (Amended) A vacuum processing apparatus

according to claim 7, characterized in that

each of the deposit shield and the shutter comprises a heating mechanism.

13. (Amended) A vacuum processing apparatus according to claim 7, characterized in that

a disk-shaped evacuation plate is disposed around the stage, and the shutter and the evacuation plate are contacted with each other and electrically connected with each other when the shutter is raised.

14. (Deleted)

15. (Added) A vacuum processing apparatus including a vacuum processing chamber having a stage mounting a substrate to be processed; and a carrier port for carrying the substrate onto and off the stage, for generating plasma in the vacuum processing chamber and for subjecting the substrate on the stage to a plasma processing, characterized by comprising:

a deposit shield disposed along an inner peripheral wall of the vacuum processing chamber, and having a notch portion at a position facing the carrier port; and

a shutter having a shape fitted into the notch portion of the deposit shield, having an inside forming a same curve as a curve of an inner surface of the deposit shield when the shutter is fitted into the notch portion, and disposed to be able to be elevated, and characterized in that

each of the deposit shield and the shutter has a ground potential, the shutter is retreated to pass through the notch portion to carry the substrate when carrying the substrate inside and outside through the carrier port, the shutter is displaced to be fitted into the notch portion of the deposit shield when the plasma processing is conducted, and a plasma generation region is surrounded by the even curve, thereby producing uniform plasma.

16. (Added) A vacuum processing apparatus according

to claim 15, characterized in that

when the plasma is generated in the vacuum processing chamber, the shutter is raised by a shutter mechanism to be fitted into the notch portion to thereby close the carrier port and an inner surface of the shutter forms the same curve as the curve of the inner surface of the deposit shield.

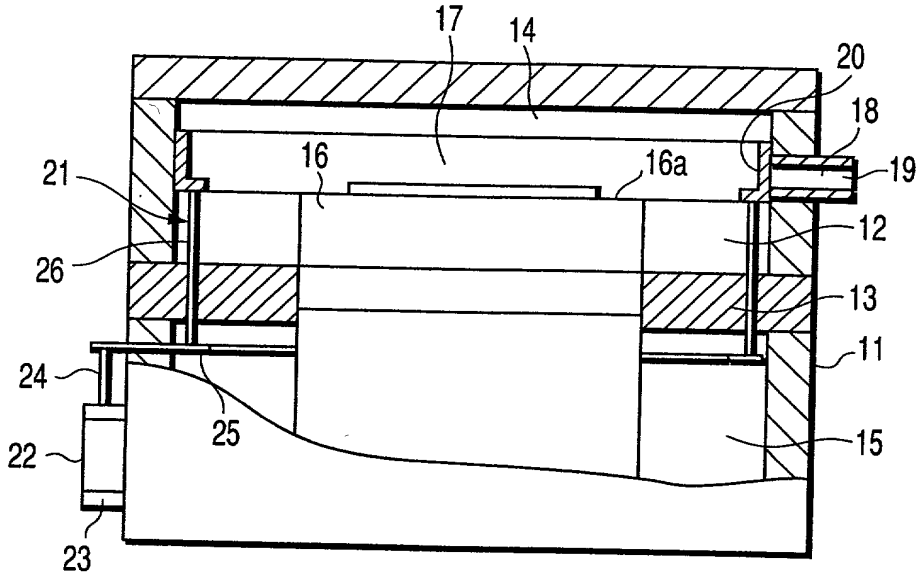


FIG. 1

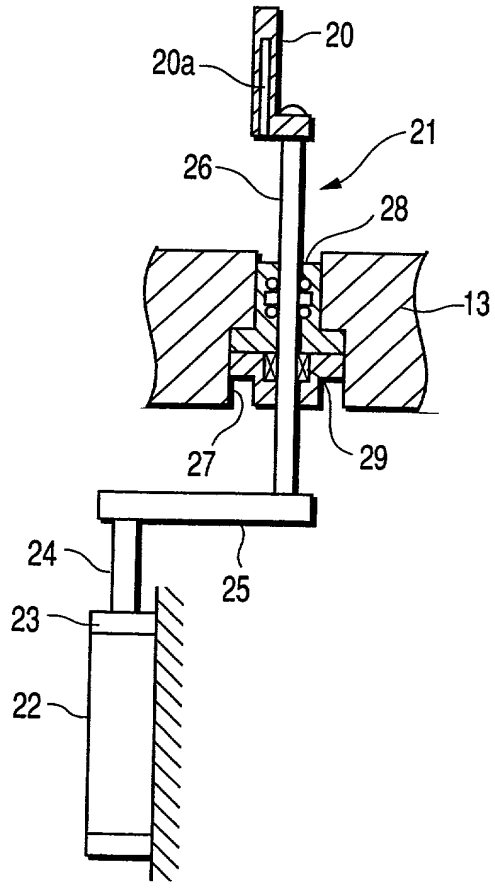


FIG. 2

FIG. 3

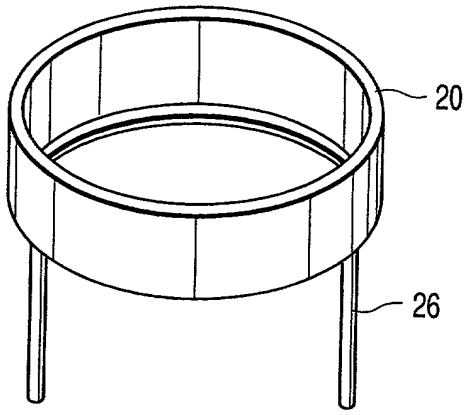


FIG. 4

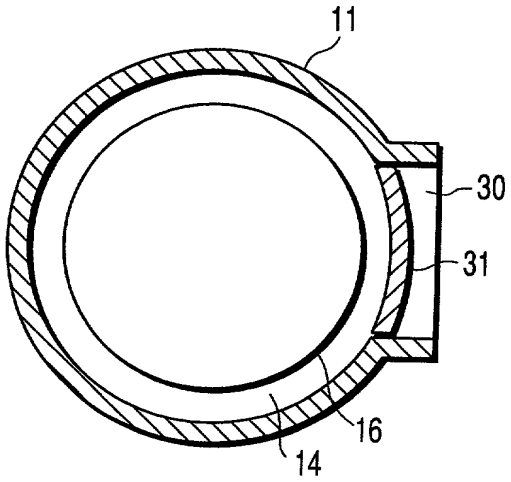
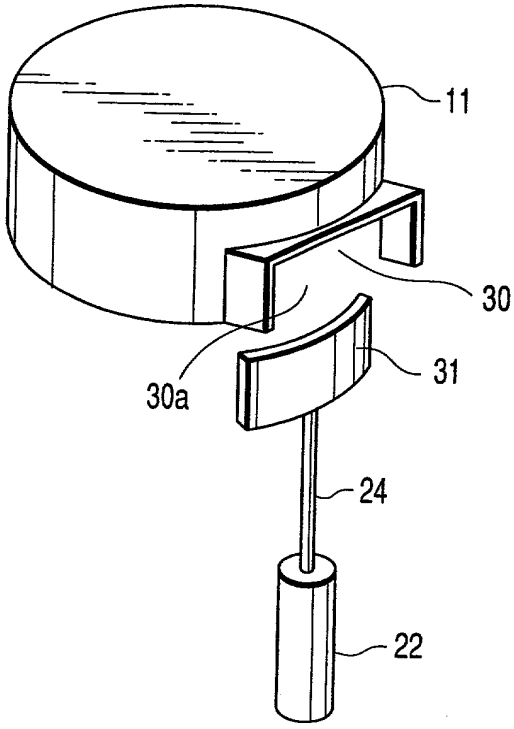


FIG. 5



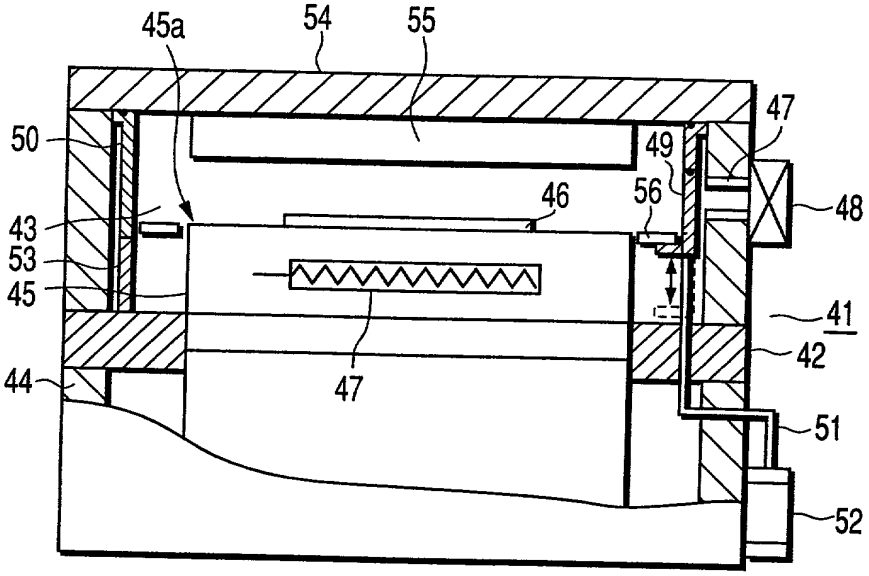


FIG. 6

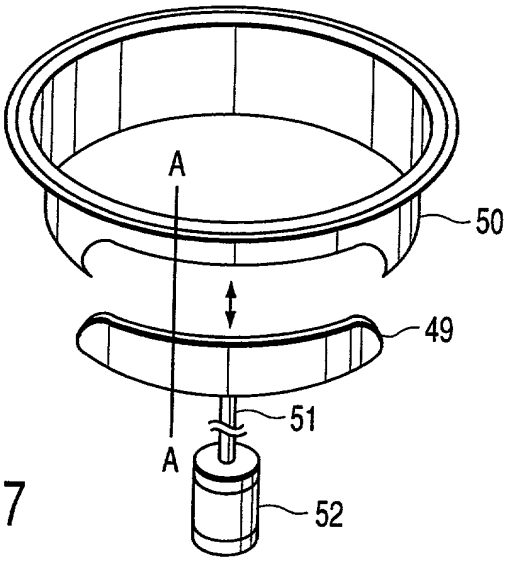


FIG. 7

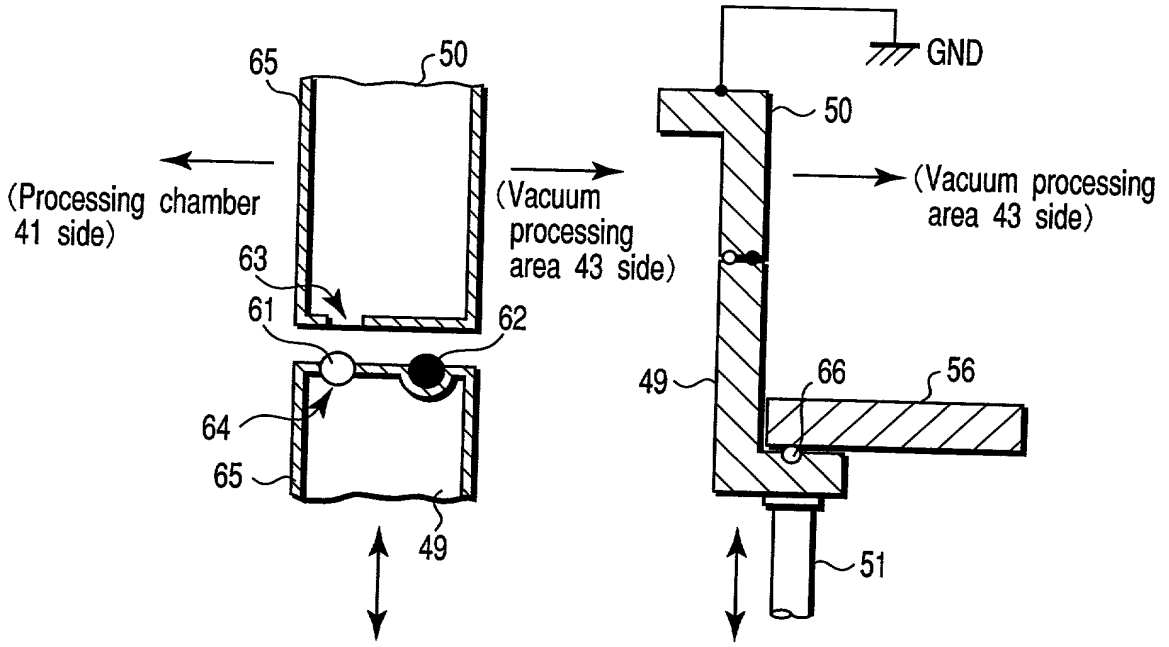


FIG. 8A

FIG. 8B

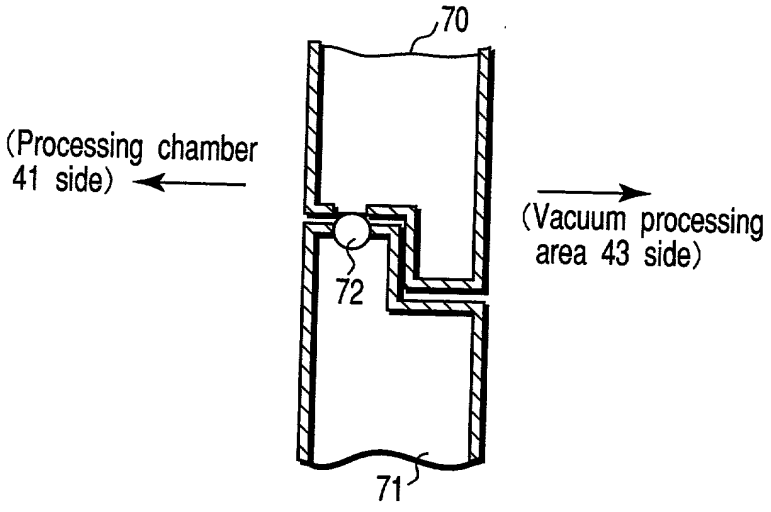


FIG. 9

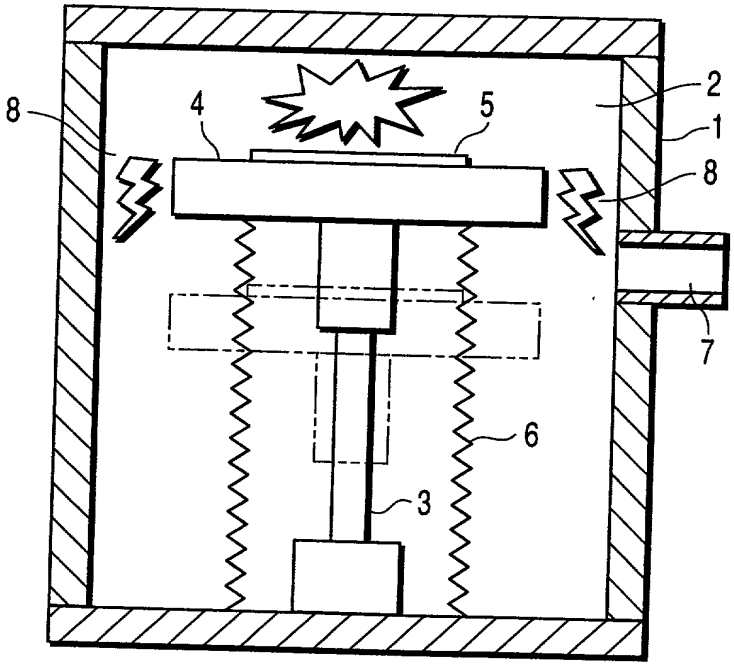


FIG. 10

Declaration Power of Attorney For Patent Application
特許出願宣言
Japanese Language Declaration

私は、下欄に氏名を記載した発明として、以下の通り宣言する：

As a below named inventor, I hereby declare that:

私の住所、郵便の宛先および国籍は、下欄に氏名に続いて記載したとおりであり、

My residence, mailing address and citizenship are as stated below next to my name,

名称の発明に関し、請求の範囲に記載した特許を求める主題の本来の、最初にして唯一の発明者である（一人の氏名のみが下欄に記載されている場合）か、もしくは本来の、最初にして共同の発明者である（複数の氏名が下欄に記載されている場合）と信じ、

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

真空処理装置

VACUUM PROCESSING APPARATUS

その明細書を
（該当するほうに印を付す）

The specification of which
(check one)

☐ ここに添付する。

☐ is attached hereto.

☒ 2000．6月2日に

☒ was filed on JUNE 2, 2000

as Application No.

出願番号第 PCT/JP00/03597 号として

PCT/JP00/03597 and was amended on

提出し、2000,11 7 2001,4 月 4 日に補正した。

November 7, 2000 and April 4, 2001 and June 21, 2001

（該当する場合）

2001,6 21

(if applicable)

私は、前記のとおり補正した請求の範囲を含む前記明細書の内容を検討し、理解したことを陳述する。

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第３７部第１章第５６条（ａ）項に従い、本願の審査に所要の情報を開示すべき義務を有することを認める。

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

Japanese Language Declaration

私は、合衆国法典第３５部第１１９条、第１７２条、又は第３６５条に基づく下記の外国特許出願又は発明者証出願の外国優先権利益を主張し、さらに優先権の主張に係わる基礎出願の出願日前の出願日を有する外国特許出願又は発明者証出願を以下に明記する：

I hereby claim foreign priority benefits under Title 35, United States Code Sec. 119, Sec. 172 or Sec. 365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior foreign application(s)
先の外国出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	Priority Claimed 優先権の主張 Yes あり	No なし
11-155039	JAPAN	02/06/1999	☒	☐
			☐	☐
			☐	☐
			☐	☐
			☐	☐

私は、合衆国法典第３５部第１２０条に基づく下記の合衆国特許出願の利益を主張し、本願の請求の範囲各項に記載の主題が合衆国法典第３５部第１１２条第１項に規定の態様で先の合衆国出願に開示されていない限度において、先の出願の出願日と本願の国内出願日又はＰＣＴ国際出願日の間に公表された連邦規則法典第３７部第１章第５６条（ａ）項に記載の所要の情報を開示すべき義務を有することを認める。

I hereby claim the benefit of Title 35, United States Code, Sec. 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Sec. 112, I acknowledge the duty to disclose any material information as defined in Title 37, Code of Federal Regulations, Sec. 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)

私は、ここに自己の知識に基づいて行った陳述がすべて真実であり、自己の有する情報及び信ずるところに従って行った陳述で真実であると信じ、更に故意に虚偽の陳述等を行った場合、合衆国法典第１８部第１００１条により、罰金もしくは禁固に処せられるか、又はこれらの刑が併科され、又はかかる故意による虚偽の陳述が本願ないし本願に対して付与される特許の有効性を損なうことがあることを認識して、以上の陳述を行ったことを宣言する。

I hereby declare that all statements made herein of my own knowledge are true; and further that all statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Japanese Language Declaration

（日本語宣言書）

委任状：私は、下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。
（弁理士、または代理人の氏名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

I hereby appoint the registrants of Oblon, Spivak, McClelland, Maier & Neustadt, P.C., Fourth Floor, 1755 Jefferson Davis Highway, Arlington, Virginia 22202, Customer No. 22850, or any one of them. Send correspondence to Oblon, Spivak, McClelland, Mailer & Neustadt, P. C., Fourth Floor, 1755 Jefferson Davis Highway, Arlington, Virginia 22202, Telephone No. (703)413-3000.

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（第二以降の共同発明者に対しても同様に記載し、署名をすること。）

(Supply similar information and signature for second and subsequent joint inventors.)

Japanese Language Declaration

（日本語宣言書）

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同第 2 発明者の署名　　日付	2nd inventor's signature Date Jun Ozawa November 19, 2001
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同第 3 発明者の署名　　日付	3rd inventor's signature Date November 19, 2001 Tomoya Okubo
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国 籍 日本	Citizenship JAPAN JPX
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同第 4 発明者の署名　　日付	4th inventor's signature Date Tatsuya Fuji November 19, 2001
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